Lake of the Woods Aquatic Vegetation Management Plan Prepared for the Lake of the Woods Property Owners Association

3119 Sea Lane
Bremen, IN 46506

Prepared By:

Jim Donahoe
David Keister

Aquatic Weed Control
P. O. Box 325
Syracuse, IN 46567

Funded by the Lake and River Enhancement (LARE) program and the Lake of the Woods Property Owners Association.

Executive Summary

Aquatic Weed Control was contracted by the Lake of the Woods Property Owners Association to develop a long term lake management plan. Funding for this plan was provided by the Lake of the Woods Property Owners Association and the Department of Natural Resources Division of Soil Conservation. This funding was part of the Lake and River Enhancement (LARE) program. Aquatic Weed Control conducted two aquatic vegetation surveys to characterize the plant community of Lake of the Woods, following protocol established by the Indiana Department of Natural Resources. A qualitative survey called the Tier I reconnaissance survey was used to obtain an understanding of the vegetation present in Lake of the Woods, and a quantitative survey (Tier II) was used to document the distribution and abundances of individual plant species in Lake of the Woods.

Based upon data collected in the two vegetation surveys, Aquatic Weed Control constructed an action plan that is designed to safely reduce the Eurasian milfoil population in the lake without harming native plant or fish species. This will preserve biodiversity in Lake of the Woods, and provide reasonable access to the lake for recreational purposes.

Since the Eurasian Milfoil is widely spread throughout the lake, treating the entire lake will be the most effective and cost efficient way to control the Eurasian milfoil. It is recommended that Lake of the Woods be treated with fluridone to control the Eurasian milfoil and to kill its roots as well. This treatment will greatly reduce the potential for re-growth of Eurasian milfoil plants. A "six bump six" lake treatment plan is recommended for Lake of Woods and is explained in more detail in the action plan.

Lake of the Woods Action Plan Costs

2005

Pretreatment aquatic vegetation survey (required by IDNR)	$1,600.00
Herbicide and application cost	$26,000.00
Post-treatment vegetation survey and plan update	$1,600.00

2006

No chemical application will be conducted in the second year of the plan.

2007

Herbicide application to areas of Eurasian milfoil re-growth	$5,000.00

2008

Pretreatment aquatic vegetation survey (required by IDNR)	$1,600.00
Herbicide application to areas of Eurasian milfoil re-growth	$5,000.00

Acknowledgements

Aquatic vegetation surveys conducted on Lake of the Woods were made possible by funding from the Indiana Department of Natural Resources and the Lake of the Woods Property Owners Association. Aquatic Weed Control would like to extend special thanks to Indiana Department of Natural Resources (IDNR) District 3 biologist Jed Pearson for providing procedural training for both Tier I and Tier II aquatic vegetation surveys. Cecil Rich, aquatic biologist for the IDNR Division of Soil Conservation provided valuable consultation regarding the requirements and objectives of this lake management plan. Brad Fink, assistant fisheries biologist, also provided assistance and training for data analysis computer programs. Jim Donahoe and David Keister of Aquatic Weed Control performed the aquatic vegetation sampling and are the authors of this report. Aquatic Weed Control would also like to thank the members of the Lake of the Woods Property Owners Association for their commitment to improving this lake and for valuable discussion and input brought forward at the informational meeting held on November 6, 2004.

Table of Contents

List of Figures

List of Tables

Introduction

Aquatic Weed Control was contracted by Lake of the Woods Property Owners Association to develop a long term lake wide management plan. Funding for this was provided by the Lake of the Woods Property Owners Association and the Department of Natural Resources Division of Soil Conservation. This funding was part of the Lake and River Enhancement (LARE). The survey and management plan are a requirement to receive additional funding to treat the lake for nuisance aquatic vegetation.

The project was initiated to take a more aggressive and long term approach to controlling the Eurasian milfoil in Lake of the Woods. LARE funding is provided by the lake enhancement fee that is paid when a person registers their boat. One third of the total money collected goes to the improvement of our Indiana lakes. This lake management plan is a requirement for obtaining state funds to manage exotic aquatic weeds.

Problem Statement

Lake of the Woods, located in northeastern Marshall County, is in need of intervention to maintain a healthy plant community, enhance recreational opportunities and control the distribution and abundance of Eurasian water milfoil.

The distribution of Eurasian water milfoil, an invasive aquatic plant, appears to be increasing from year to year. Eurasian milfoil is of primary concern because of its aggressive nature and its destructive effects on lake ecosystems. This nuisance species grows and spreads rapidly, forming dense weed beds that rob native plants of the light and nutrients they need to survive.

In lakes where Eurasian milfoil is left unchecked, well-diversified plant communities can be decimated and replaced by a single species. Eurasian milfoil has the ability to overwinter, giving it a distinct growth advantage over many native plants. The milfoil lies dormant during the winter months instead of dying completely. As spring arrives, the dormant milfoil plants have a head start on many native plants and reach the surface faster, shading out the natives. Eurasian milfoil grows profusely, provides poor fish habitat, inhibits boat navigation, and causes annoyances and even serious health hazards to skiers, swimmers, and other members of the public wishing to enjoy the lake.

The increasing abundance of Eurasian milfoil in Lake of the Woods is alarming because the adverse effects of this plant are well documented. Over the past five years, specific areas of the lake have been selectively treated with contact herbicides. These treatments have provided short-term relief from the milfoil, but the overall abundance of milfoil still appears to be increasing.

All past chemical treatment on Lake of the Woods was conducted upon the requests of lake residents. Some individuals chose to treat small areas of lake frontage to increase recreational access to the lake. Most of these treatments used contact herbicides and provided only temporary relief from the milfoil problem. All of these treatments were

privately funded. The action plan outlined in this report should provide a basis for more effective long term control of Eurasian milfoil.

Management Goals:

The following management goals have been established by the IDNR for all lakes applying for LARE funding.

1. Develop or maintain a stable, diverse aquatic plant community that supports a good balance of predator and prey fish and wildlife species, good water quality and is resistant to minor habitat disturbances and invasive species.

2. Direct efforts to preventing and/or controlling the negative impacts of aquatic invasive species.

3. Provide reasonable public recreational access while minimizing the negative impacts on plant and wildlife resources.

Specific Objectives:

The following steps are recommended to help achieve the management goals.

1. **The first priority will be to stop the milfoil from spreading to new areas of the lake**. This is of primary importance to the native plant community in Lake of the Woods. Since native plants do not compete well with milfoil, containing the spread of milfoil is the best strategy to stop the loss of native plants.

2. **The existing areas affected by the milfoil must be treated to maintain a reasonable level of control**. Reducing the population of Eurasian milfoil in areas where it has already gained a foothold will provide multiple benefits. Recreational activities like swimming, fishing, skiing and boating will all be enhanced by reducing the Eurasian milfoil population. It is also important to note that reducing existing beds of milfoil may provide an opportunity for native plants to reclaim areas where they have been excluded for years. The hope is that the beneficial native plants will gradually replace the invasive milfoil.

3. **Vegetation surveys should be conducted to evaluate the effectiveness of the management plan.** Prior to chemical treatment, Lake of the Woods will be surveyed for Eurasian milfoil to document its distribution and abundance. After chemical treatment, changes in its population can be evaluated by additional vegetation surveys. These surveys will also serve to monitor native plant populations to ensure that biodiversity is maintained in Lake of the Woods.

Until this point, management strategies have been geared to provide short-term relief from the milfoil on a yearly basis. While chemical treatments over the past five years have succeeded in giving some relief from the milfoil, this management plan will focus

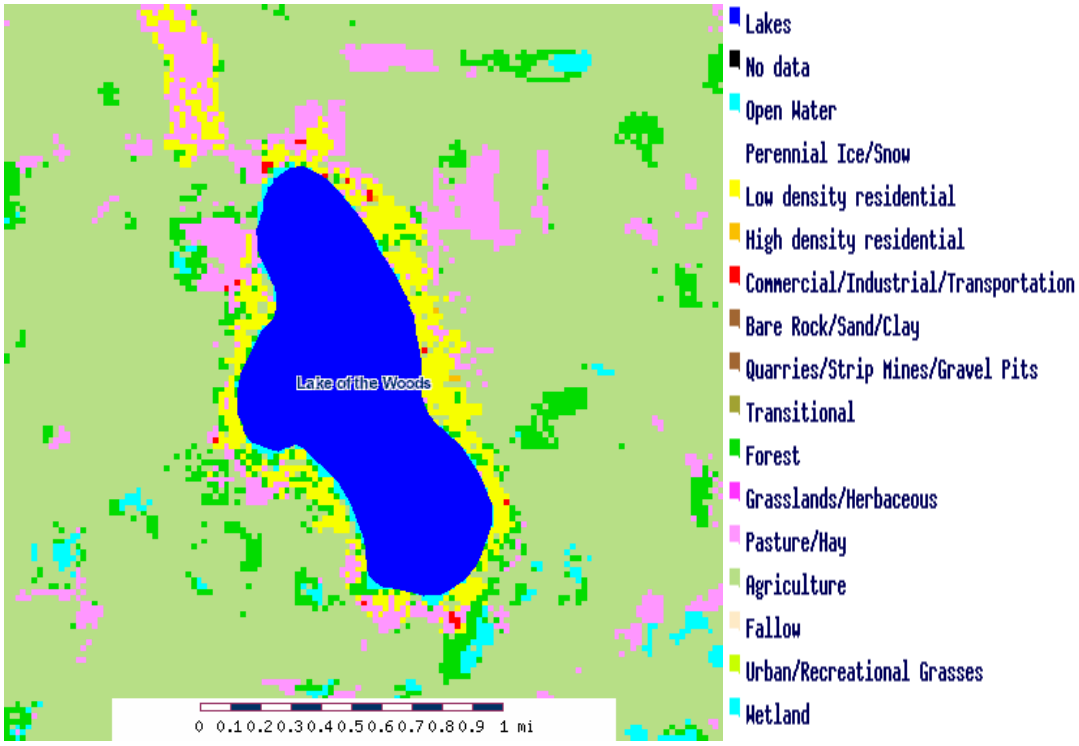
on stopping the spread of this invader, and reducing the amount of yearly maintenance needed to keep the Eurasian milfoil in check.

Water Shed and Water Body Characteristics

Lake of the Woods, located near Bremen, IN, has 416 surface acres with a maximum depth of 48 feet and an average depth of 16 feet. Although no recent diagnostic studies have been completed describing the watershed, the area around the lake is subject to heavy agricultural use. Large amounts of agricultural activity in this watershed make Lake of the Woods prone to heavy sediment loading (Tyllia, 2000). Nearly 80% of the shoreline of Lake of the Woods is developed, which can also cause complications in the form of sewage, storm water and fertilizers entering the lake. A relatively new lake-wide sewer system has been installed, and has helped to reduce nutrient runoff into the lake.

Water quality is considered poor in Lake of the Woods when compared to many Indiana lakes. Secchi disk readings are approximately 3.0 ft and phosphorus levels are very high. These high levels of nutrients promote large blooms of blue-green algae (Kalff, 2000). This reduces water clarity, which can greatly impede the growth of native plants. Unfortunately, milfoil grows readily in these conditions. This further compounds the effects of this intruder and reinforces the urgent need for control of the milfoil. This report is not designed to be a watershed study but a plan to manage the nuisance aquatic weeds. However, it is best to mention some of these water shed characteristics since an integrated lake management plan is desired. Figure 1 shows the watershed around the lake.

Figure 1: Land Use Around Lake of the Woods



Lake of the Woods Fisheries

The most recent fisheries survey conducted by The Indiana Department of Natural Resources took place on June 6, 1996. Data was obtained by using electro-fishing and gill nets to collect, count, measure, and then release fish. A total of 23 species of fish were collected, many of which were valuable game fish (Sportsmen's Connection, 2000).

Bluegills were most abundant, accounting for 57.7 percent of the total fish community. Walleye were also sampled in good numbers and good sizes for northern Indiana. Walleye are highly sought after and lakes with good populations can be extremely difficult to find in Indiana. The presence of a stable walleye population only adds to the value of this excellent fishery. Other popular game fish include largemouth bass, white and black crappies as well as white bass and yellow perch (IDNR Fisheries Survey, 1996).

Gizzard shad were also sampled in this survey. Gizzard shad can have harmful effects on many game fish populations, especially those who are dependent upon plankton for survival. Gizzard shad are very efficient planktivores, and compete with "young of the year" fish for food. They reproduce rapidly, even faster than other proliferate species such as crappies and bluegills. They can quickly take over an ecosystem and rob other fish of valuable food sources. The one upside to a large gizzard shad population is that they provide an excellent food source for game fish such as largemouth bass, white bass, walleyes and crappies. A table summarizing the fisheries survey is included below.

Table 1 IDNR Fisheries Survey 6/2/96

Species	Total # Collected	Percentage	Size Range (in.)
Bluegill	294	57.7	2.0-8.6
Carp	27	7.3	19.7-27.4
Spotted Gar	22	4.3	12.3-41.5
Gizzard Shad	20	3.9	10.1-15.6
Walleye	17	3.3	7.3-22.4
White Crappie	13	2.5	4.8-10.2
White Bass	12	2.4	9.2-11.5
White Sucker	12	2.4	6.8-17.4
Yellow Perch	11	2.2	5.3-8.3
Yellow Bullhead	11	2.2	7.0-10.6
Channel Catfish	10	2.0	11.5-22.5
Pumpkinseed	9	1.8	3.8-6.8
Largemouth Bass	9	1.8	6.1-14.1
Golden Shiner	7	1.4	1.5-8.8
Black Crappie	6	1.4	8.3-9.9
Black Bullhead	4	0.8	7.5-10.3
Quillback	3	0.6	20.0-21.5
Warmouth	2	0.2	6.4-6.7
Spotted Sucker	1	0.2	14.8

Redear Sunfish	1	0.2	3.5
Brown Bullhead	1	0.2	14.7
Hybrid Sunfish	1	0.2	6.5
Smallmouth Buffalo	1	0.2	16.8

At the time of this survey many healthy populations of game fish were documented. Unfortunately, the spread of Eurasian milfoil in Lake of the Woods poses a serious and significant threat to these populations. Eurasian milfoil can shade out many native plants and take over lakes quickly. Eurasian milfoil reduces the abundance of beneficial native species that provide excellent fish habitat. The result is a poorly diversified plant community, composed mainly of milfoil, which provides extremely poor fish habitat. Controlling the Eurasian milfoil is very important to help protect the fishery of Lake of the Woods.

Present Water Body Uses

Today, Lake of the Woods is highly valued to many stakeholders for a number of reasons. This is a relatively large lake for this area, and the lake has no speed limit restrictions. These factors make this lake ideal for speedboats, water-skiing, jet skis and other fast moving forms of recreation.

In addition to these activities, Lake of the Woods has an excellent fishery, harboring good populations of many popular game fish such as walleye, large mouth bass, and white bass.

The public access along the southwest shore of the lake on West Shore Drive opens this lake to thousands of citizens in the surrounding area. The residents living on Lake of the Woods share this lake with the general public. Any management practices implemented on Lake of the Woods will benefit both the lake residents and a large number of stakeholders who visit the lake on a regular basis. The size, location and accessibility of Lake of the Woods make it an excellent site to implement management strategies that will save a valued ecosystem and benefit a large number of people.

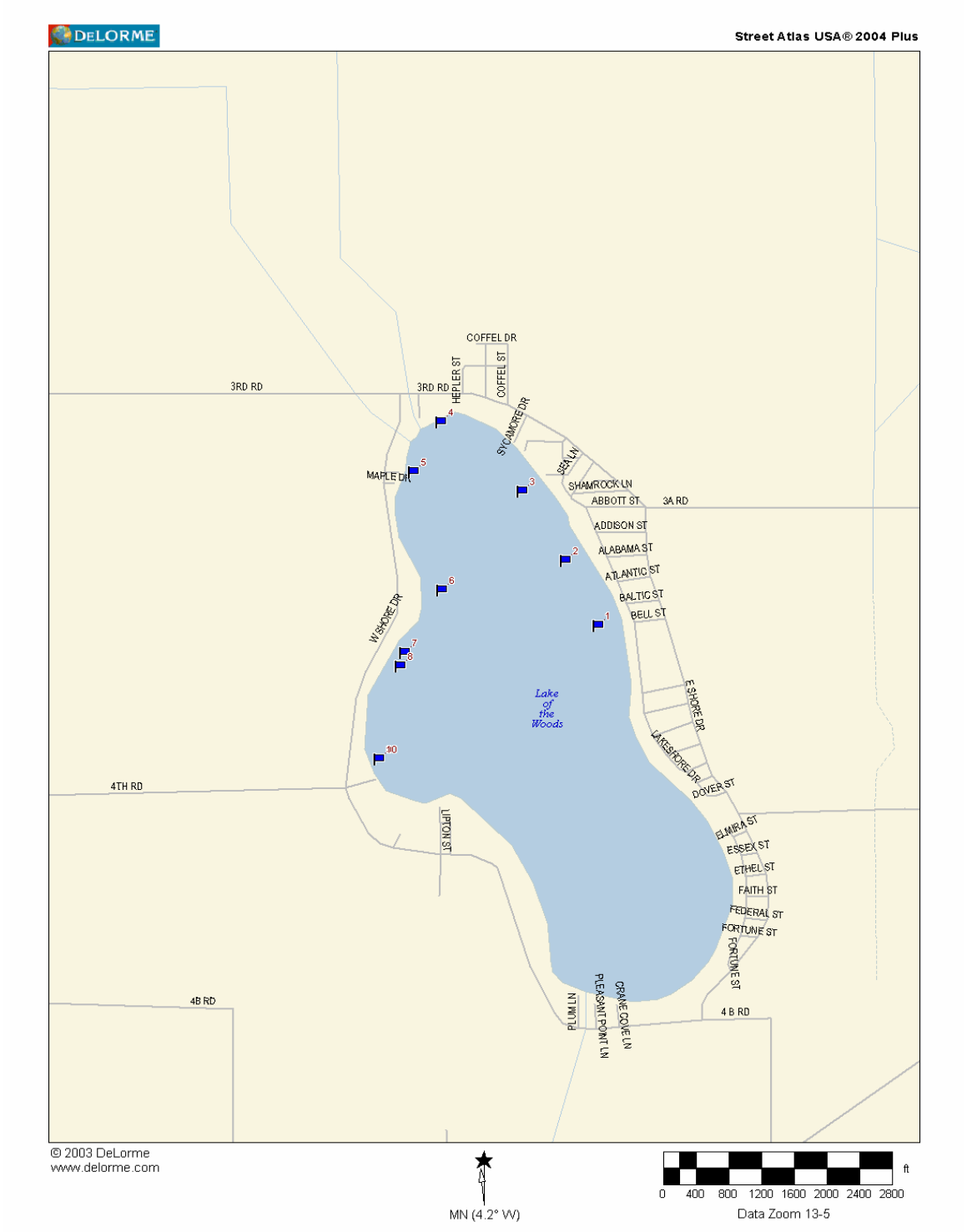
Characterization of the Plant Community

It is important to note that sediment loading in the lake contributes to poor water quality and clarity, making accurate Tier I reconnaissance surveys very challenging.

Another extremely important note is that Eurasian Water milfoil may occur at greater frequencies and at higher densities than indicated by these surveys. Any chemical treatments prior to the surveys will kill out milfoil beds that would have otherwise appeared in the Tier I and Tier II plant surveys. Poor water clarity and previous chemical applications may result in an underestimation of the true distribution and abundance of Eurasian milfoil in Lake of the Woods. Approximately 29 acres of Eurasian milfoil were treated in 2004 prior to this survey. Figure 2 is a map of the Tier I

plant bed locations. The exact shapes of each bed were not drawn. However, GPS coordinates were taken at the center of the bed and at the maximum lakeward extent of each plant bed.

Figure 2: Tier I Plant Bed Locations



Lake of the Woods Tier I Survey Methods

The Tier I reconnaissance survey is designed to identify the major plant beds present in a body of water. This is a qualitative survey designed to give an overview of the aquatic vegetation present in a lake. It identifies and documents problem areas that can be targeted when management practices are implemented. Major submersed plant beds are found visually from a boat. Each bed is given a reference number that is recorded on Tier I data sheets. The general location of these beds are recorded on a bathymetric map of the lake, and more precise locations are recorded on Tier I data sheets with the help of a WAAS enabled GPS unit.

When a major plant bed is identified, each species of plant found in that bed is recorded. Canopy ratings are given to each plant bed based on the types of plants present in that bed. The four major types of plants to be identified in this study are as follows: submersed plants, emergent plants, non-rooted floating plants and rooted floating plants. The following scale is used to describe these four types of plants based on the percentage of the plant bed canopy they occupy:

Canopy Rating

1 = <2% of canopy
2 = 2-20%
3 = 21-60%
4 = >60% of canopy

In addition to the canopy rating, another abundance rating is given to each individual species found in a particular plant bed. This abundance rating is based on the percentage of the entire bed area that species appears to occupy. The scale for this abundance rating is the same as the canopy rating scale. The difference is that this scale identifies the abundance of *individual species* in the bed:

Species Abundance Rating

1 = < 2% of the bed
2 = 2-20%
3 = 21-60%
4 = >60% of the bed

Since this is a visual survey, results are dependant upon the surveyor's ability to locate plants below the water's surface. Tier I surveys are much less effective in lakes with low secchi disk readings. Polarized glasses were used to reduce glare from the sun and enable the surveyors to see more easily into the water. Even with the aid of polarized glasses, the Tier I survey should not be considered an exhaustive survey of aquatic vegetation. The Tier I survey is a tool that helps to provide an overall picture of an aquatic plant community when coupled with the Tier II quantitative survey.

Tier I Plant Bed Summary

Plant Bed #1
This plant bed had an approximate size of 1/10 acre and contained one species of aquatic plant. Coontail was the only species found in the bed and was very dense with an abundance rating of 4.

Plant Bed #2
This plant bed had an approximate size of ¼ acre and contained only one plant species. Eurasian milfoil was the only plant present in this bed and had an abundance rating of 4.

Plant Bed #3
This Plant bed had an approximate size of 1/10 acre and contained two plant species. Coontail and Eurasian milfoil were both present and both had abundance rating of 3.

Plant Bed #4
This plant bed had an approximate size of ¼ acre and contained coontail and Eurasian milfoil. In this bed coontail had an abundance rating of 3, and Eurasian milfoil was very dense, with an abundance rating of 4.

Plant Bed #5
This plant bed had an approximate size of ¼ acre and contained only Eurasian milfoil. In this bed Eurasian milfoil was very dense, with an abundance rating of 4.

Plant Bed #6
This plant bed had an approximate size of 1 acre and contained only Eurasian milfoil as well. In this bed, Eurasian milfoil had an abundance rating of 4.

Plant Bed #7
This plant bed had an approximate size of 1/10 acre and contained only Eurasian milfoil. In this bed Eurasian milfoil was very dense, with an abundance rating of 4.

Plant Bed #8
This plant bed had an approximate size of ¼ acre and also contained only Eurasian milfoil In this bed Eurasian milfoil was very dense again, with an abundance rating of 4.

Plant Bed #9
This plant bed had an approximate size of 1 acre and contained only Eurasian milfoil. In this bed Eurasian milfoil was very dense, with an abundance rating of 4.

Plant Bed #10
This plant bed had an approximate size of 1/10 acre and contained only Eurasian milfoil. In this bed Eurasian milfoil was very dense, with an abundance rating of 4.

Tier I Survey Summary

The ten major plant beds identified in Lake of the Woods each contained only 1 to 2 plant species and covered over 2 acres of the lake. Eurasian Milfoil was the dominant plant in this survey occurring nine times with an average abundance score of 3.89. Coontail was also abundant when found (3.33) but much less frequent, being found only in three plant beds.

Naiad, chara, sago pondweed and Illinois pondweed were collected in the Tier II survey but were not observed in the Tier I survey. With the exception of sago pondweed, these species grow closer to the lake bottom, and poor water clarity makes them extremely difficult or impossible to see from above the water's surface. This underscores the importance of the Tier II sampling process in order to gain an accurate representation of the aquatic plant community.

Materials and Methods: Tier II Random Sampling

Summary

A Tier II quantitative survey of Lake of the Woods was conducted on August 25, 2004. The purpose of this survey was to document the distribution and abundance of submersed and floating-leaved aquatic vegetation throughout the lake (IDNR, 2004). A specific number of sample sites were selected based on the amount of surface acreage the lake possessed. Once sample sites were determined, sampling was accomplished using an aquatic vegetation sampling rake constructed according to the guidelines of the 2004 Tier II random sampling procedure manual.

Aquatic vegetation collected at each sample site was sorted according to species, and given a value to represent its abundance at that site. These values were immediately recorded on data sheets distributed by the IDNR. These records were used for data analysis that served to characterize the aquatic vegetation community of Lake of the Woods.

Random Sampling

IDNR aquatic biologist Cecil Rich issued the following chart to help determine the number of sample sites needed to accurately describe the aquatic plant community in a lake.

Table 2: Number of Sample Sites Based on Lake Size

Size of Water body	Number of Sample Sites
1-100 acres	40

101-300 acres	60
Greater than 300 acres	Add 10 sites/100 acres

Based on Lake of the Wood's 416 surface acres, approximately 80 sample sites were needed to accurately describe this plant community. Aerial photographs and bathymetric maps were used to evenly space the sample sites throughout the lake. The littoral zone of the lake was divided into four quadrants of equal length. During the vegetation collection process, an effort was made to collect plants from 20 sites in each quadrant to ensure that the entire littoral zone was surveyed adequately and that random sample sites were distributed evenly throughout the lake.

When sampling the littoral zone of the lake, a pattern was used that also helped to ensure an accurate description of the plant community. The littoral zone was divided into three sections based on depth and sample sites alternated between each of these three zones. For example, collection site 1 would be taken in shallow water very close to shore. Collection site 2 would be taken further down the shoreline, but in slightly deeper water. Collection site 3 would be taken further down the shoreline, but in even deeper water, close to the border of the littoral and pelagic (open water) zone. This sampling strategy was recommended by District 3 fisheries biologist Jed Pearson. This strategy not only helps to accurately describe the plants in the littoral zone, but it also aids in determining the maximum depth at which plants can grow in particular lake.

Aquatic Vegetation Sampling Rake:

A double-headed garden rake was used to sample aquatic vegetation. This rake design is approved and used by IDNR fisheries biologists in vegetation surveys on many Indiana lakes. It consists of two garden rake heads welded together back to back so that rake teeth are protruding from two sides. The dimensions of the rake are to be 13.5 inches wide with 2.25-inch long teeth spaced 0.75 inches apart (IDNR, 2004).

Each tooth on the rake head is divided into five equal sections and marked accordingly. These marks on the rake teeth are used to estimate the abundance of plant species when they are collected.

A nylon rope is then attached to the rake head. A black permanent marker is used to mark the rope in foot long increments. A red mark is placed every five feet along the rope. This rope is used to measure the depth at each sample site when the rake is lowered to the lake bottom.

GPS and Mapping

A WAAS enabled GPS unit was used to obtain and record the coordinates of each sample site on the lake. A WAAS enabled GPS unit is accurate to within 3 meters and was

recommended by aquatic biologist Cecil Rich to obtain maximum accuracy for mapping sample sites. All GPS coordinates were then used to produce computer generated maps of the lake with each sample site labeled on the map.

Sampling Procedure

A two-person crew accomplished Tier II aquatic vegetation sampling by boat. A crew leader was responsible for driving the boat to each sample site and recording vegetation data on record sheets issued by the IDNR. An assistant was responsible for collecting the aquatic plants using the double-headed rake.

When a sample site was reached, its GPS coordinates were obtained and recorded. The boat was then brought to a complete stop and the double-headed rake was lowered to the bottom of the lake. The boat was held stationary while the water depth at the sample site was obtained by using the marked rope attached to the rake.

When water depth had been recorded, the crew leader slowly backed the boat away from the rake as the assistant simultaneously let out another ten feet of rope. During this process the rake did not move from the lake bottom.

The rake was pulled from the water after the boat had reached the end of the ten extra feet of rope let out after the depth was recorded. This ensured that the rake was pulled horizontally through the water, giving it a greater chance of collecting weeds than if the rake had been lowered to the bottom and raised vertically. The vegetation caught on the teeth of the rake was then gathered into the boat.

Determining Vegetation Abundance

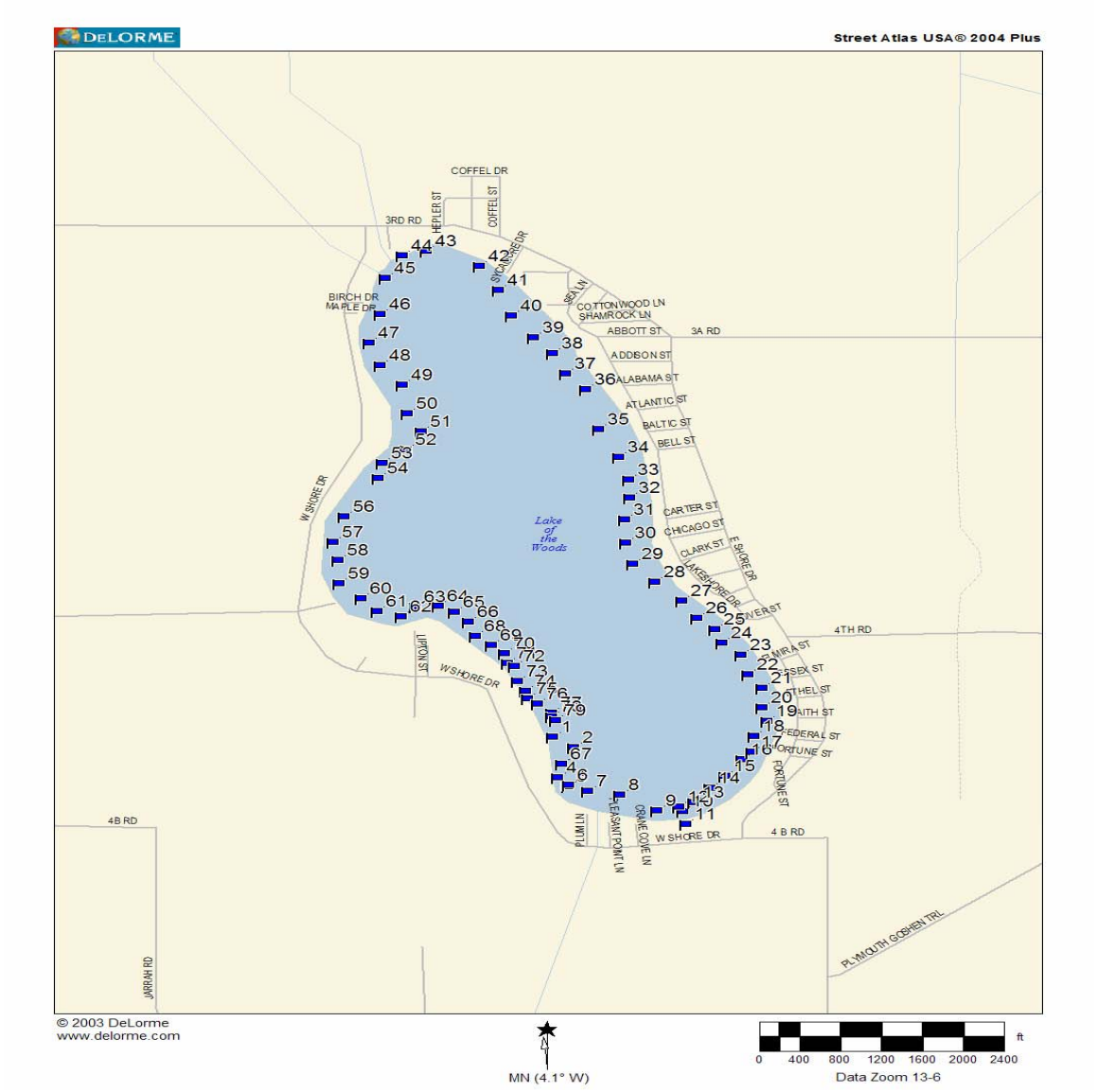
At each sample site, every plant species collected on the rake was scored according to its abundance. This was accomplished by removing all plants from the rake and sorting them by species. Once all plants had been sorted, they were placed back onto the rake and evenly distributed across the marks on the rake teeth. If a species filled the rake to the first mark on the teeth, that species was given a score of one on the abundance data sheet. If it filled the rake teeth to the second mark, it was given a score of two, and so on to a maximum abundance of five.

In many instances it was not necessary to place each species back onto the rake. Many species would fill the rake completely (an abundance of 5) and some species would only have one plant on the rake (an abundance of 1). In addition to abundance scores for individual species, each rake toss was given an overall abundance score, describing how much total vegetation was collected on the rake. Figure 3 shows all sample points taken in the Tier II survey.

Tier II Survey Results

Secchi depth was taken prior to the survey and determined to be approximately 3.0 feet. A total of six species of aquatic plants were collected during the Tier II survey. Of these species, one of them (Eurasian milfoil) was an exotic species. The average number of total species collected at each sample site was 0.97 while the average number of native species collected at each site was 0.56. The species diversity index for Lake of the Woods was 0.61 while the native plant diversity index was 0.38. Average rake density was 1.16 while average rake diversity was 0.62. The diversity index of native plants collected on the rake was 0.39. Chara and coontail had the highest average densities at 2.0, while naiad had the greatest relative density at 0.65. The most dominant plant in this survey was naiad with a dominance index of 12.9. The next most dominant plant was Eurasian milfoil with a dominance index of 11.6.

Figure 3: All Tier II Sample Points



Lake of the Woods Tier II Survey Results

August 25, 2004

Total # of sample sites: 79

Total # of species: 6

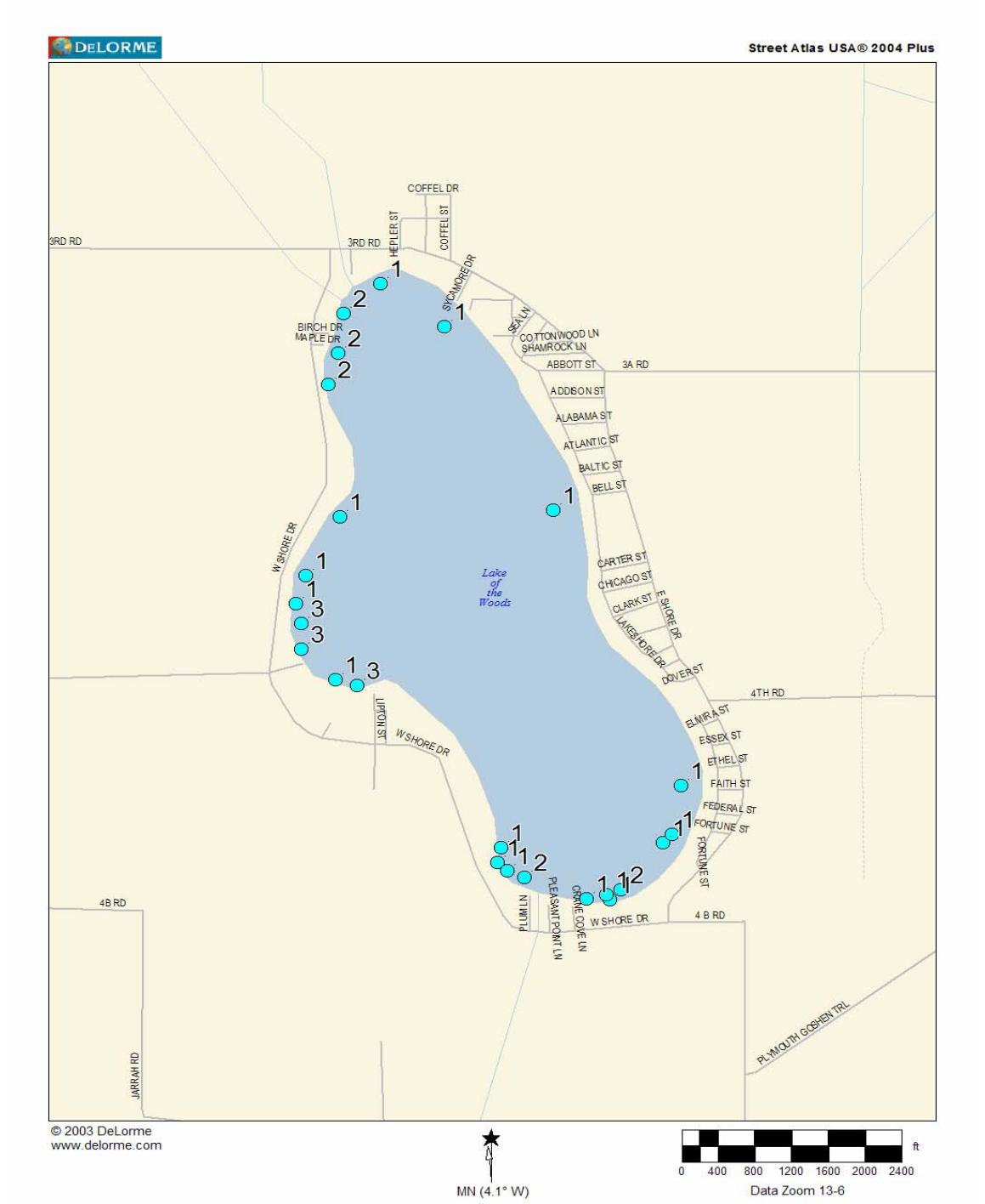
Species List

Eurasian Milfoil
Coontail
Naiad
Chara
Sago Pondweed
Illinois Pondweed

Table 3: Tier II Survey Results Summarized

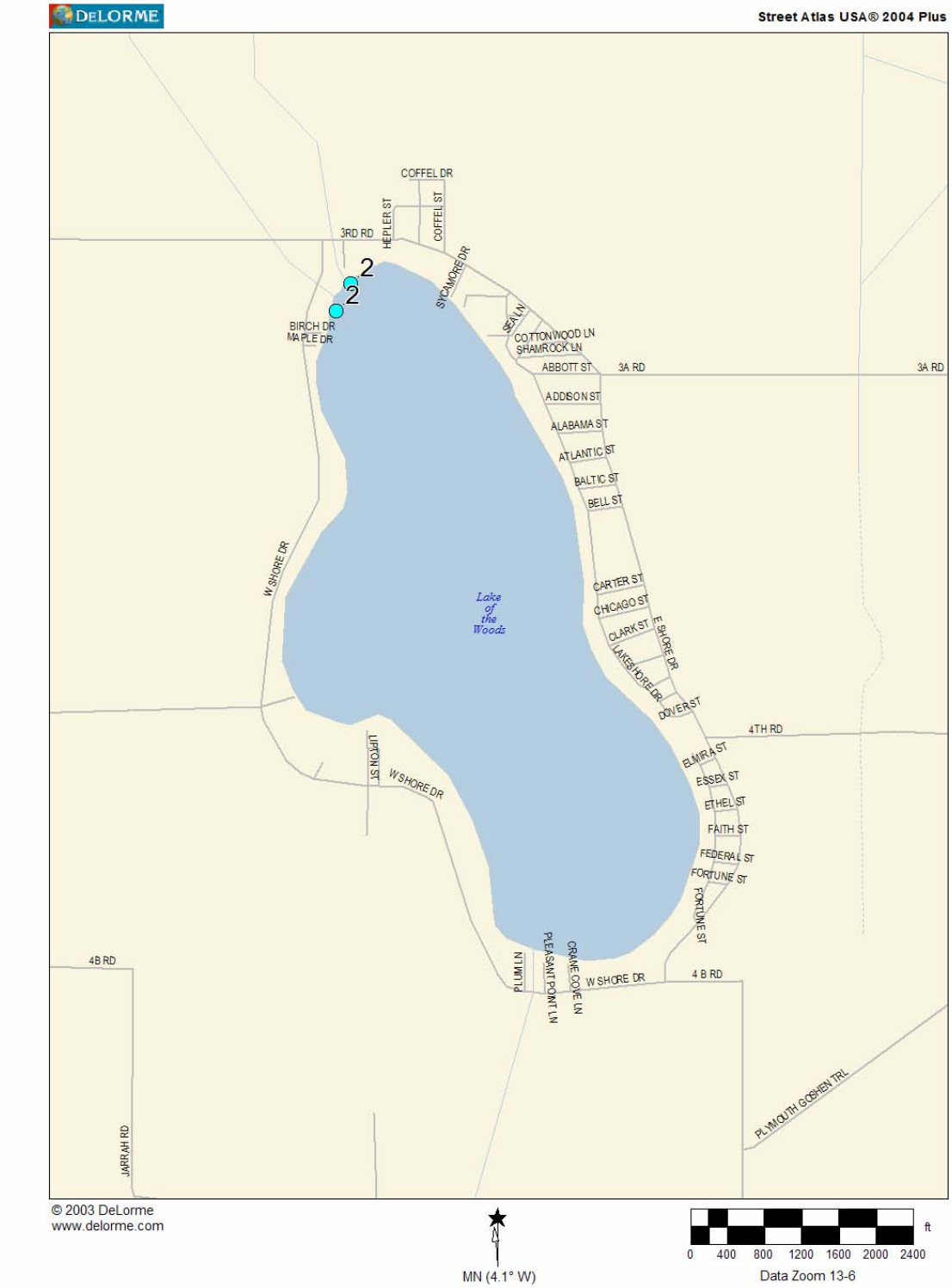
Species	# Of Sites Present out of 79 total sites	Average Abundance
Naiad	27	1.48
Eurasian Milfoil	26	1.50
Coontail	2	2.00
Chara	2	1.00
Sago Pondweed	2	1.00
Illinois Pondweed	1	3.00

Figure 4: Sites Where Eurasian Milfoil was Collected



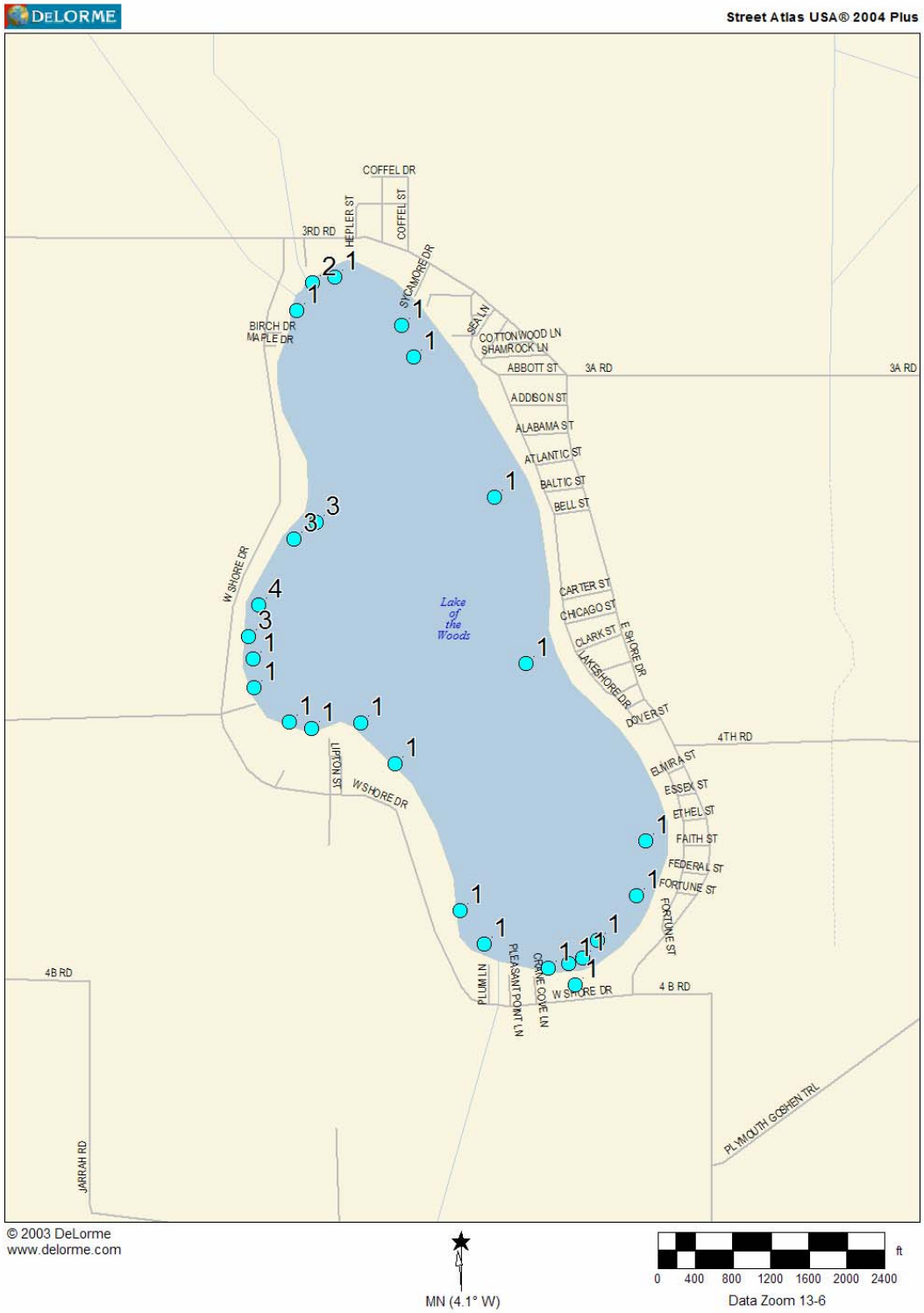
Eurasian milfoil is widely spread throughout lake of the woods. It is most abundant along the south and the west shores of the lake. Some Eurasian milfoil beds along the east shore of the lake may not be represented due to chemical treatment prior to this survey. Approximately 29 acres of Eurasian milfoil had been treated prior to this survey.

Figure 5: Sites Where Coontail was Collected



Native coontail is very scarce in Lake of the Woods as shown by this map. It was collected only twice in the Tier II survey. Both collection sites were located in the northwest corner of the lake.

Figure 6: Sites Where Naiad was Collected



Species of naiad were the most common plants collected during this Tier II survey. They were especially common in the south and west portions of the lake and had their highest abundance ratings in the northwest section of Lake of the Woods.

Table 4: Tier II Data Analysis

Occurrence and Abundance of Submersed Aquatic Plants

Date:	8/25/04	Littoral sites with plants:	38	Species diversity:	0.61
Littoral depth (ft):	9.0	Number of species:	5	Native diversity:	0.38
Littoral sites:	62	Maximum species/site:	3	Rake diversity:	0.62
Total sites:	79	Mean number species/site:	0.97	Native rake diversity:	0.39
Secchi:	3.0	Mean native species/site:	0.56	Mean rake score:	1.16

Common Name	Site frequency	Relative density	Mean density	Dominance
Chara	1.6	0.03	2.00	0.6
Coontail	3.2	0.06	2.00	1.3
Eurasian Water milfoil	40.3	0.58	1.44	11.6
Sago Pondweed	6.5	0.10	1.50	1.9
Naiad sp	38.7	0.65	1.67	12.9
Naiad sp	32.1	0.54	1.67	10.7
Illinois Pondweed	3.3	0.02	0.50	0.3

Species Diversity and Species Dominance

Two of the most important values in Table 5 are the diversity indices and the species dominance values. A species diversity index is actually measured as a value of uncertainty (H). If a species is chosen at random from a collection containing a certain number of species, the diversity index (H) is the probability that the chosen species will be different from the previous random selection. The diversity index (H) will always be between 0 and 1. The higher the H value, the more likely it is that the next species chosen from the collection at random will be different from the previous selection (Smith, 2001). This index is dependant upon species richness and species evenness, meaning that species diversity is a function of how many different species are present and how evenly they are spread throughout the ecosystem.

Species dominance is dependent upon how many times a species occurs, and its relative coverage area or biomass within the system. In this survey, the abundance rating given to each species at each sample site was used to determine dominance. The dominance of a particular species in this Tier II survey increases as its site frequency and relative abundance increase.

Threatened and Endangered Species

No threatened or endangered species were found during the Tier I or the Tier II survey. Relatively poor water quality and an abundance of invasive plants are not conducive to the survival of these species (Smith and Smith, 2001). Controlling the Eurasian milfoil would promote a more diverse ecosystem with greater species richness. This may provide a better opportunity for threatened plants to gain a foothold in this body of water. However, the poor water quality of Lake of the Woods is not beneficial to many fragile species of threatened plants. (Kalff, 2002)

Aquatic Management Plan

Lake of the Woods is heavily infested with Eurasian milfoil. Eurasian milfoil was introduced to North America in the mid 1940's and has spread throughout the east coast to northern Florida to the Midwest. It is present in about 75 % of the areas currently treated by Aquatic Weed Control. Eurasian milfoil spreads by fragmentation, seeds, and has the ability to over-winter from year to year. Once it is in a lake it generally becomes the dominant plant species because it forms dense canopies on the water which shade out the native more beneficial weed species below. There is also increasing evidence that mat forming species like Eurasian milfoil exert significant negative impacts on a broad range of aquatic organisms. (Pullman, 1998).

No Action and Other Alternatives

If no action is taken the Eurasian milfoil will only get worse since the milfoil grows by fragmentation. Fragmentation means that if the plant is cut, the fragment has the ability to re-grow. Eurasian milfoil also over winters as an adult plant so new generations are spawned every season, therefore the Eurasian milfoil beds become more dense if left untreated.

Mechanical Harvesting

Mechanical harvesting uses a machine to cut the weeds. These machines pick up the cut weeds but will still leave small fragments that will have the ability to re-grow. Also, after an area is harvested the Eurasian milfoil generally re-grows first causing the native plants to be shaded out again. Mechanical harvesting is also not selective in its control. The harvesting will cut the native weed species as well as the exotics if both are present in the same area. For the above reasons mechanical harvesting is not recommended.

Harvesting can be accomplished by individual owners around their dock area. A lake property owner can legally harvest a 625 square foot area. (25 feet by 25 feet).

Biological Control

The milfoil weevil is a native North American insect that consumes Eurasian milfoil and northern watermilfoil. The weevil was discovered after a decline in Eurasian milfoil population was discovered in Brownington Pond, Vermont (Creed and Sheldon, 1993). The milfoil weevil burrows down into the stem of the plant and consumes the tissue of the plant. Holes where the larvae burrow in allow disease to get established and the holes also release the plants' gases causing the plants to loose buoyancy and sink (Creed ET. Al. 1992).

The problem with using the milfoil weevil is that they have not yielded consistent results. Why they work in one lake and not another is still not well documented. In 2003 Scribailo and Alix conducted a weevil test on Round Lake in Indiana and found no conclusive evidence that the Eurasian milfoil populations were reduced.

Environmental Manipulation

Draw down of the lake level is another way to control the Eurasian milfoil problem in the lake. Lower water levels expose the Eurasian milfoil to freezing and thawing. However, this plan is not selective as it will control the natives as well. Also, this will cause the Eurasian milfoil to grow in deeper water. For these above reasons draw down is not recommended for Lake of The Woods.

Chemical Control

Aquatic chemicals come in two types. There are contact and systemic herbicides. Systemic herbicides kill the roots of the plants. Examples of systemic herbicides are Sonar and Avast (flouridone active ingredient) and Navigate, Aqua Kleen, DMA4 (active ingredient 2,4-D) and Renovate (Trichlophyr active ingredient). All of these chemicals are effective in killing the Eurasian milfoil by the roots. Based on the author's experience and other lake managers in the Midwest, whole lake treatments of flouridone are the best at controlling Eurasian water milfoil provided the current population in a lake warrants this type of treatment. Flouridone can be applied at low rates to control the Eurasian milfoil and not control the majority of the native weed species present in the lake.

2, 4-D and Trichophyr are both root control herbicides which have the ability to be used in small areas where Eurasian milfoil is present. If fluridone is used, the whole lake needs to be treated. The major difference between 2,4-D and Trichophyr is that trichophyr is showing that it may have the ability to control the Eurasian milfoil in select areas longer than 2,4-d. Please remember that Renovate has only been available for use for the past

two seasons. The ability of Renovate to provide more long term control of Eurasian milfoil than 2,4-D in spot treatment situations is still being documented. 2,4-D is less expensive to use but if Trichophyr continues to show better long term control in treated areas it will be a better investment in the long run.

Contact herbicides are used best to control the majority of the weeds around people's piers and in man-made channels. Contact herbicides are the not the best choice to reduce the Eurasian milfoil problem in Lake of the Woods since they are not selective and do not control the weeds by the roots. Examples of contact herbicides are Reward (active ingredient Diquat), and Aquathal (active ingredient Endothal).

The public's primary concern with the use of chemical is safety. This should not be a concern since extensive testing is completed prior to a chemical being delivered to the market. These tests demonstrate that the chemical is safe for the environment and will not have adverse effects on humans or the animal population in a lake when used properly.

Action Plan

Since the Eurasian Milfoil is widely spread throughout the lake, treating the entire lake will be the most effective and cost efficient way to eradicate the Eurasian milfoil. It is recommended that Lake of the Woods be treated with fluridone to control the Eurasian milfoil and to kill its roots as well. This treatment will greatly reduce the potential for re-growth of Eurasian milfoil plants.

This plan has been discussed with Bob Robertson (IDNR biologist for Lake of the Woods) and a treatment permit would be issued as long as the lake is not treated in the following year (2006). Fluridone would be applied in late April or early May and would take between 90 and 120 days to achieve control of Eurasian milfoil. The chemical applicators would use a "6 bump 6" program to achieve maximum control in Lake of the Woods. This means the entire lake would be treated with 6 PPB (parts per billion) of fluridone. After the initial treatment, applicators will allow three weeks for the fluridone to be absorbed by the Eurasian milfoil. At the conclusion of 3 weeks from the initial treatment date, water samples will be taken to determine the concentration of fluridone still present in Lake of the Woods. After determining this concentration, a second application of fluridone will take place to increase its concentration back to 6PPB.

These low chemical rates would have no adverse effects on the fish or native plant species. Stress imposed upon fish would be greatly reduced since Eurasian milfoil would die out over the course of 90 to 120 days. This extended die off period protects against dramatic fluctuations of dissolved oxygen which could be harmful to fish. The following treatment costs are estimated based on lake size, chemical and application costs, and LARE funding requirements.

Whole-Lake Treatment Costs

2005

Pretreatment aquatic vegetation survey (required by IDNR)	$1,600.00
Herbicide and application cost	$26,000.00
Post-treatment vegetation survey and plan update	$1,600.00

2006

No chemical application will be conducted in the second year of the plan.

2007

Herbicide application to areas of Eurasian milfoil re-growth	$5,000.00

Residents might want to consider spraying any heavy areas of natives with contact herbicides around their piers and shorelines.

2008

Pretreatment aquatic vegetation survey (required by IDNR)	$1,600.00
Herbicide application to areas of Eurasian milfoil re-growth	$5,000.00

Residents might want to reconsider spraying any heavy areas of natives with contact herbicides around their piers and shorelines.

Public Involvement and Education

An informational meeting was held by the Lake of the Woods Property Owners Association on November 6, 2004. This meeting was held in order to inform the public about the problems facing Lake of the Woods, especially about the threat that Eurasian milfoil poses to both the ecology and the utility of the lake. Potential solutions to these problems were discussed and Jim Donahoe of Aquatic Weed Control offered potential management strategies that could be used to control the Eurasian milfoil and reclaim Lake of the Woods both for ecological and recreational purposes. A second public meeting will be held in January or February to discuss the plan further.

It is important that information about management practices on Lake of the Woods be made available to the public. Lake association meetings and newsletters are excellent avenues through which this information can be distributed. Informational signs could also be posted at the public boat landing and any other lake access areas. Also, a summary of management practices funded by the LARE program would make an excellent addition to the annual fishing regulations guide and other IDNR publications. Additional information on aquatic management can be found at the following web sites: www.mapms.org www.aquatic.org www.apms.org www.nalms.org.

Monitoring and Evaluation of the Action Plan

As the action plan is implemented, a pretreatment vegetation survey will help to monitor the effectiveness of the management strategy. The abundance and distribution of Eurasian milfoil will be recorded using the same protocols included in this report. The new data sheets and data analysis files will be added to the current lake management plan. This will provide applicators, property owners, and the IDNR with detailed records describing the changes in the plant community of Lake of the Woods.

After one year, additional surveys can be conducted to determine the distribution and abundance of Eurasian milfoil. This will determine if the management strategy has been effective in reducing the Eurasian milfoil population from one year to the next.

In the years that follow, additional surveys should be conducted to determine how the Eurasian milfoil population is reacting to the management strategy over a long period of time. These surveys will provide a basis for evaluation of the management strategy and can be presented to the public should the need arise to modify the management strategy. They will also serve to keep the public interested and informed about management practices at Lake of the Woods so they will be motivated and equipped to actively participate in the conservation of the Lake of the Woods ecosystem.

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Appendix A: Macrophytes of Lake of the Woods

The following appendix was compiled using information found in the 5th edition of How to Identify Water Weeds and Algae, edited by James C. Schmidt and James R. Kannenberg.

Six major species were identified in the Tier I and Tier II aquatic vegetation surveys.

1. **Naiad**

   Scientific name: *Najas minor* (brittle naiad)
   Classification: Native to Indiana
   Distribution: Common Throughout the U.S.
   Presence in Lake of the Woods: collected at 27 of 79 sample sites

   Description: The leaves of naiad plants are usually widest at the base and gradually become thinner near the tip of the leaf. Plants are extremely leafy and appear bush-like when viewed from above the surface of the water. Many species of naiad are very common in this area. Plant structure often resembles chara, but the absence of calcium deposits on the surface of the plant help in identification. The leaves of brittle naiad have multiple spines along the margins that are visible to the naked eye.

2. **Eurasian Milfoil**

   Scientific Name: *Miriophyllum spicatum*
   Classification: Exotic in Indiana
   Distribution: Common in the Midwest and Eastern U.S. Also spreading along the Pacific coast
   Presence in Lake of The Woods: Collected at 26 of the 79 sample sites.

Description: This extremely aggressive and extremely destructive plant has leaves in whorls of 4 around a reddish stalk. This plant grows rapidly and can reach lengths of over 10 feet. This plant has the ability to over-winter, meaning it can lie dormant during the winter months instead of dying out completely each year. This gives it a distinct advantage of many native species, as it competes for sunlight in early spring. The dormant milfoil plants reach the surface much faster than the native plants sprouting from the lake bottom. This enables the Eurasian milfoil to shade out other plants and form the dense beds that choke the littoral zone of many lakes.

A reproductive process called fragmentation aids the rapid dispersion of Eurasian milfoil. If a milfoil plant is damaged and some fragments are removed from the macrophyte, each small piece of the plant has the ability to grow roots and create a new milfoil plant. Eurasian milfoil is considered one of the most dangerous aquatic nuisance species because of its ability to rapidly disrupt and destroy lake ecosystems.

3. Coontail

Scientific name: *Ceratophyllum demersum*
Classification: Native to Indiana
Distribution: Coontail is common throughout the U.S., usually in hard water.
Presence in Lake of the Woods: Collected at 2 of the 79 sample sites.

Description: Coontail plants are submersed and have no roots, though they appear to be attached to the lake bottom when viewed from above the surface of the water. The free-floating nature of coontail allows it to colonize new areas of a lake quickly, and it often times forms extremely dense weed beds where sufficient light and nutrients are available. Coontail has dark green leaves arranged in whorls around the stem and usually grows in long, bushy strands resembling evergreen trees beneath the surface of the water. Coontail's structure is very similar to Eurasian milfoil but coontail has forked leaves, which distinguishes it from the feather-like projections of Eurasian milfoil leaves.

4. Chara

Scientific name: *Chara sp*.
Classification: Native to Indiana
Distribution: Extremely common worldwide. Found in hard water.
Presence in Lake of the Woods: Collected at 2 of 79 sample sites

Description: Chara is often mistaken for a vascular plant, but it is actually an advanced form of algae. It can be gray, green or yellow in color and is usually forms extremely dense beds that may cover an entire lake. It can be identified by its distinct musky odor and calcium deposits on the algae's surface make it feel bristly to the touch. It possesses leaf-like structures that are whorled around the hollow stem, and it attaches itself to the lake bottom although it has no actual roots. It usually grows in shallow, clear water.

5. **Sago Pondweed**

Scientific name: *Potemogeton pectinatus*
Classification: Native to Indiana
Distribution: Found throughout the U.S., Very common in the northern 2/3 of Indiana
Presence in Lake of the Woods: Collected at 2 of the 79 sample sites.

Description: Sago Pondweed has a bushy appearance with narrow, thread-like leaves that spread out to resemble a fan. Leaves are usually 1/16 of an inch wide and 1 to 6 inches long. Nutlets are formed on a string-like structure and protrude from the surface of the water. While sago pondweed can form dense beds, many times it is found in sparse, loosely distributed arrangements.

6. **Illinois Pondweed**

Scientific name: *Potamogeton illinoensis*
Classification: Native to Indiana
Distribution: Very widespread and very common throughout the U.S.
Presence in Lake of the Woods: Collected at 1 of the 79 sample sites.

Description: Illinois pondweed is extremely common in Indiana, especially in the northern third of the state. This leafy weed has leaves with very broad bases that extend three-fourths of the way around the stem. The upper part of its slender stem is usually branched and very leafy.

Appendix B: Tier II Data Sheets

Table 5: Tier II Survey Point by Site Number

			Lake of the Woods Tier II Survey				
				Plants Present			
		MYSP2	CEDE4	NAFL	CH?AR	POPE 6	POIL
		Eur. Milfoil	**Coontail**	**Naiad**	**Chara**	**Sago**	**Illinois Pondweed**
Site #							
1							
2							
3		1					
4		1					
5							
6		1					
7		2		1			
8							
9		1		1			
10		1					
11				1	1		
12		1		1			
13		2		1			
14				1			
15							
16		1					
17		1		1			
18							
19							
20		1		1			
21							
22							
23							
24							
25							
26							
27							
28							
29				1			
30							
31							
32							
33							
34		1					
35				1			

36							
38							
39						1	
		MYSP2	CEDE4	NAFL	CH?AR	POPE 6	POIL
		Eur. Milfoil	**Coontail**	**Naiad**	**Chara**	**Sago**	**Illinois Pondweed**
40				1			
41		1		1			
42						1	
43		1		1			
44			2	2			
45		2	2	1			
46		2					
47		2					
48							
49							
50							
51							
52				3			
53		1		3			
54							
55		1		4			
56		1		4			
57		1		3			
58		3		1			
59		3		1			
60							
61		1		1			
62		3		1			
63							
64					1	1	
65				1			
66							
67				1			
68						3	
69				1			
70							
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79							